IMPLEMENTATION OF BIOLOGICAL STANDARDS AND CRITERIA IN MAINE'S WATER CLASSIFICATION LAW

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Abstract

Maine has established statutory biological standards in its water classification. This was done with the intent of establishing a set of impact standards which directly measure the biological integrity of the water, a stated goal of both federal and state law. By using the biological standards and associated criteria in a planning role, much of the constraints on use and language, which might be imposed in a regulatory system were avoided. This allowed for definitions and criteria to be written from a technical-scientific perspective, and also allowed greater discretionary use of professional judgement in making biological evaluations. Maine's biological program is created with a set of three narrative standards in its law which range from that sufficient to attain the interim fishable/swimmable goals of the federal act to full maintenance of integrity in a natural status. These narrative standards are further defined in statute with a set of scientific definitions for terms in the standards. These defintions identify specific ecological attributes which may be tested by a hierarchical scheme of tests of descending power and increasing professional judgement to arrive at a decision as to whether a standard is achieved.

Introduction

In the early 1980's, the State of Maine found that its water quality laws were deficient and a new water classification law was passed in 1986 (Maine Revised Statutes Annotated, Title 38, Sections 464 to 468). There were three significant factors which created a need for this change in the law. First, radical improvements had taken place in water quality over much of the state. While improvements had been predicted by water quality models for dissolved oxygen, for instance, it had always been unclear how these improvements would affect the aquatic biota. Within a few years, observation of the reinvasion of many pollution tolerant species was documented. Direct observation could also be made of how differing levels of treatment and loading rates affected the aquatic biota. With this information, the water classification law was found to be deficient in describing the biotic resources of the state.

Secondly, standards and criteria in Maines law did not represent the most current scientific information. In addition to revising standards for dissolved oxygen and enteric bacteria, it was decided that the current knowledge of the aquatic community processes was sufficient to enable application of classification standards and standardized methods and criteria for Maines waters. Use of community assessment is a cost effective measure since it is a direct, holistic evaluation of water quality goals.

Finally, water quality management was evolving in a way which demanded new methods of assessment and more integrated evaluations of water quality. The state is in its third round of licensing. Licenses will

Table 1. Aquatic life classification scheme for Maine's rivers and streams.

Rivers and Streams Classes	Management Perspective	Level of Biological Integrity
AA	High quality water for preservation of recreational and ecological interests. No discharges or impoundments of any kind permitted.	Aquatic life shall be as naturally occurs
A	High quality water with limited human interference. Discharges restricted to noncontact process water or highly treated wastewater of quality equal to or better than the receiving water. Impoundment permitted.	Aquatic life shall be as naturally occurs.
B	Good water quality. Discharges of well treated effluents with ample dilution permitted.	Ambient water quality sufficient to support life stages of all indigenous aquatic species. Only nondetrimental changes in community composition may occur.
C	Lowest quality water. Requirements consistent with interim goals of the Federal Water Quality Act (fishable and swimmable).	Ambient water quality sufficient to support the life stages of all indigenous fish species. Changes in species composition may occur but structure and function of the aquatic community must be maintained.

not be modified unless there is demonstrated impairment of water quality sufficient to affect uses. Former water quality standardswere limited in their ability to detect use impairment. Thus, the biota could offer a feedback mechanism to assess the actual goals for habitat improvement being sought through the licensing system. Water quality management was also evolving through new amendments to the Water Quality Act of 1987 requiring new and added assessment requirements for toxics and nonpoint source pollution as well as traditional assessment requirements. Because toxics and nonpoint source assessments often involve compound pollutants and complex interactions, the biota can lend new insight into the effects of the pollutants.

In order to change Maines water quality program to place significant emphasis on biological assessment, systematic accountability had to be provided. First, a basis in state and federal law for the use of biological information in water quality classification had to be established. The law also needed to be understandable to the public and most notably the legislature. Secondly, demonstration of administrative accountability had to be established. A new biological program had to contribute needed information that other standards and criteria could not provide. The standards also had to be logistically.

Table 2. Definitions of terms appropriate for establishing water quality criteria.

Term	Definition
As naturally occurs	Conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity.
Community	Mechanisms of uptake, storage and transfer of function life-sustaining materials available to a biological community which determines the efficiency of use and the amount of export of the materials from the community.
Community structure	The organization of a biological community based on numbers of individuals within different taxonomic groups and the proportion each taxonomic group represents of the total community.
Indigenous	Supported in a reach of water or known to have been supported according to historical records compiled by State and Federal agencies or published scientific literature.
Natural	Living in, or as if in, a state of nature not measurably affected by human activity.
Resident biological community	Aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant. This shall be established by accepted biomonitoring techniques.
Unimpaired	Without a diminished capacity to support aquatic life.
Without detrimental changes in the resident biological community	No significant loss of species or excessive dominance by any species or group of species attributable to human activity.

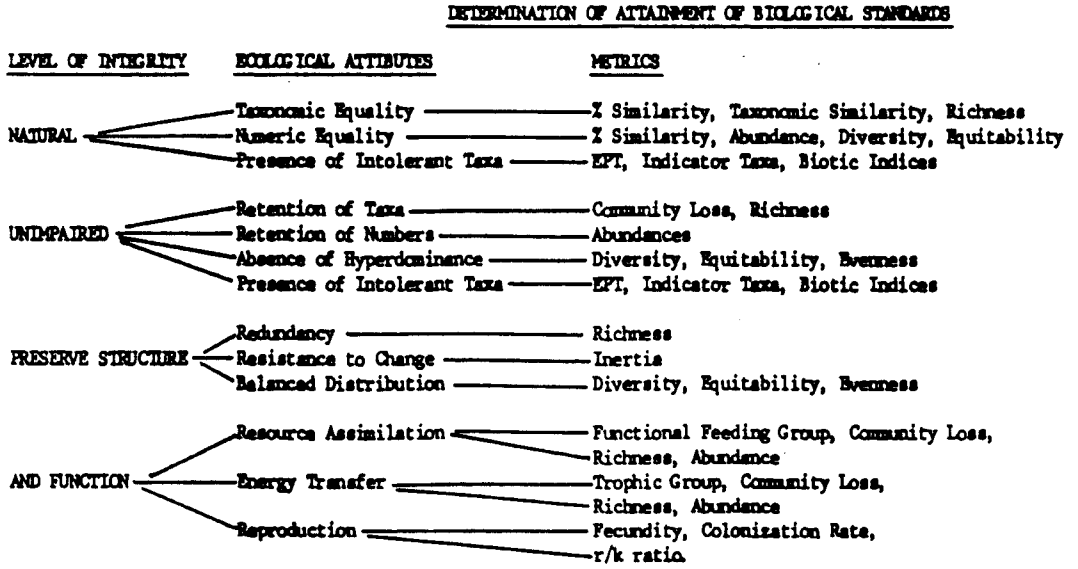

Fig. 1. Determination of Attainment of biological standards.

Finally, there had to be scientific accountability. The biological standards and criteria had to have a solid basis in ecological principales. Field methods and analytical techniques had to be reproducible and accurate.

Development of Biological Standards and Criteria-- Four general questions need to be addressed to provide accountability to a system of biological standards and criteria: 1). what are the goals and purposes, 2). how will the biological standards and criteria be used to achieve those goals and purposes, 3). how can goals be defined biologically, and 4). what sort of decision process is appropriate for biological information.

Goals and Purposes: One of the goals of the Federal Water Quality Act, stated in section 101, is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". The problem is to define integrity. All waters, even the most polluted have integrity. Therefore, one must examine the Act further to find what is an allowable range for integrity. Certainly, one standard for integrity is conditions which would be found in waters having no discharges, since another goal of the Act is to eliminate all discharges. A second standard for integrity may be found in the interim goals of the Act which requires water sufficient "for the protection and propagation of fish, shellfish, and wildlife".

Within these bounds set by the Water Quality Act, Maine has established three levels of integrity for flowing freshwaters in its water classification law (Table 1). Class AA and A standards require the biological community to be "as naturally occurs". This is analogous to conditions found without discharges. Class B standards require the aquatic community to be unimpaired by water quality conditions. Discharges are allowed, however, they must only result in changes to the community regarded as benign (e.g. recruitment of new species, increased numbers). All indigenous species must be supported and this typically occurs where nontoxic effluents are discharged into waters with ample dilution. Class C standards require that the structure and function of the aquatic community must be protected. There may be considerable replacement of pollution tolerant species, by tolerant species in Class C waters. All indigenous fish species must be supported by water quality, however, they are not required to be present in a given water body if other factors of habitat or biological interaction preclude their establishment. Class C standards in Maine law are considered analogous to the interim goals of the federal act. Tests for attainment of classification are based on effluent toxicity tests to determine support for indigenous organisms in Class B and C, and measurements of the ambient macroinvertebrate community to determine the status of the resident biological community.

Uses for biological standards: Water quality standards may be used in two ways, a regulatory approach or a planning approach. The regulatory approach is traditional and uses performance standards to regulate selected outputs (e.g. dissolved oxygen). They focus on a single pollutant, are simple to

Table 3. Criteria key to attainment of class A level of integrity "as naturally occurs" (taxonomic equality, numerical equality, presence of intolerant taxa).

1. Percent similarity > [0.7].....A
   [0.7] percent similarity > [0.3].....2
   Percent similarity < [0.3].....non attainment.(NA)
   Comparison not possible.....6

2. Taxonomic similarity > [0.8].....3
   Taxonomic similarity < [0.8] and [0.6].....4
   Taxonomic similarity < [0.6].....NA

3. Percent similarity of * dominant taxa > [0.7].....A
   Percent similarity of dominant taxa < [0.7] and [0.5].....4
   Percent similarity of dominant taxa < [0.5].....NA

4. Taxonomic similarity of dominant taxa > [0.9].....5
   Taxonomic similarity of dominant taxa < [0.9] but may be attributable to natural habitat differences **.....6
   Taxonomic similarity of dominant taxa < [0.9], but habitat similar.....NA

5. Community richness, diversity, and total abundance are all ± [0.8], of reference community.....A
   Community richness, diversity, and total abundance ± [0.6 to 0.8] of reference community.....Indeterminant
   Community not as above.....NA

6. Ephemeroptera, Plecoptera and Trichoptera all present and EPT richness > Diptera richness.....7
   Ephemeroptera and Trichoptera present.....9
   Not as above.....NA

7. Diversity > [3.0].....A
   Diversity < [3.0].....8

8. Equitability > [0.6].....A
   [0.6] > Equitability > [0.3].....Indeterminant
   Equitability < [0.6].....NA

9. Ephemeroptera and Trichoptera compose at least [50%] of dominant taxa.....7
   Ephemeroptera and Trichoptera compose less than 50% of dominant taxa...NA

* Dominant taxa are those which compose more than [5%] of total community population.

** Habitat differences exceed ranges recommended in "Methods for Biological Sampling and Analysis of Maine's Waters".

[ ] denotes an undetermined value.

use, good for modeling and enforcement, but are limited in scope and not directly goal oriented. Biological standards are not suitable as performance standards. The planning approach uses impact standards which regulate multivariate outcomes, such as community response. They are an integrative standard which focuses on the state of the resource and are a direct measure of goals. They are not well suited to modeling, are retroactive, and have limited enforcement value. Impact standards provide the manager with a direct means to evaluate the progress of water quality improvements gained through the implementation of various programs (e.g. NPDES, construction grants, nonpoint source).

Definitions of Biological Standards: Integrity may have a multitude of definitions, however, the Federal Water Quality Act may be interpreted as having bounds on the extent of allowable degradation. Within these bounds, Maine has established three narrative biological standards of integrity. These narrative standards must be further refined by establishing appropriate ecological attributes specifically suited to each standard. In Maine, this was done in statute through a set of definitions, which define critical terms in each standard (Table 2). It is important that each definition be ecologically sound. By identifying ecological attributes uniquely associated with each standard, specific metrics can be identified for use in the development of criteria (Fig. 1). For example, the term "as naturally occurs" is defined as conditions with essentially the same physical, chemical, and biological characteristics as found in situations with similar habitats free of measurable effects of human activity. From this definition, it is apparent that various tests of similarity are most appropriate for testing integrity in Class AA and A waters. Criteria are developed for each class based on metrics sensitive to the ecological attributes associated with the standard and will vary across classes.

Decision Process: Maine's water classification statute is explicit in setting biological standards and defining the terms in those standards. From these definitions, an array of metrics can be identified. It is important that these metrics be used in a consistent manner to provide the most reliable assessment. To do this, the metrics are used in a hierarchical sequence using the most powerful metrics first, and relying on secondary tests when the primary tests do not yield clear results. Ecological evaluation is known for large variability in results. To take this into account, Maine's system of criteria evaluation uses a series of trichotomous tests (Table 3). Where results of a metric show a strong pass or fail value, that result is considered valid. Where results are in between, and significance of a particular value is not clear, the hierarchical sequence moves on to other metrics, which test components of the first test, or provide other information about the status of the community. The hierarchical sequence also allows for use of professional judgement and escapes where samples are found to be nonrepresentative due to influences of sampling methods, habitat differences or other factors not associated with water quality.